

Networks problem sheet 1

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1 Introduction

- (1.a): I've already got some programming experience in matlab which guided my decision to never use it again. I will choose to use python, as I don't know it yet.
- (1.b): I primarily used website 'learnxiny' ¹to learn the syntax. This was enough for me as a reference to get started. Any other problems I had I consulted the python docs.²
- (1.d): The format (gml) seems to simply be a text file, firstly defining the nodes and their attributes (label, id) and then a definition of the edges, with edge attributes. The power network didn't have any labels, so I had to manually tell `networkx.read_gml` to take the id as labels. I used the US Power grid dataset[1], and the Les Misérables[2] dataset. I shall call these power and lesmis, respectively.
- (1.e): Firstly, the lesmis dataset, I generated a graph visualisation centered on the node with the highest degree, as shown in Fig. 1. As expected, this node represented the main character of the book. Fig. 2 shows that the second-highest degree nodes had significantly fewer connections than the highest, further showing that the highest-degree character appears with a much more varied audience.

For the power dataset, I firstly used python and networkx to generate a csv file with the degree distribution, then plotted it using R with ggplot2. I also used R to analyze the data. Firstly, I plotted the log-log graphs as shown in Fig. 4. This fit wasn't linear enough to deem correct, and so I moved on to a log-plot as in Fig. 5, which clearly showed a linear behaviour in the subset of degrees [2, 14]. From this, I extracted the exponential behaviour as $\exp(8.25 - 0.528 * degree)$. Fig. 6 shows that there are a large number of "leaf" nodes, namely, nodes which only connect to one other node.

¹<https://learnxinyminutes.com/docs/python/>

²<https://docs.python.org/3/c-api/set.html>

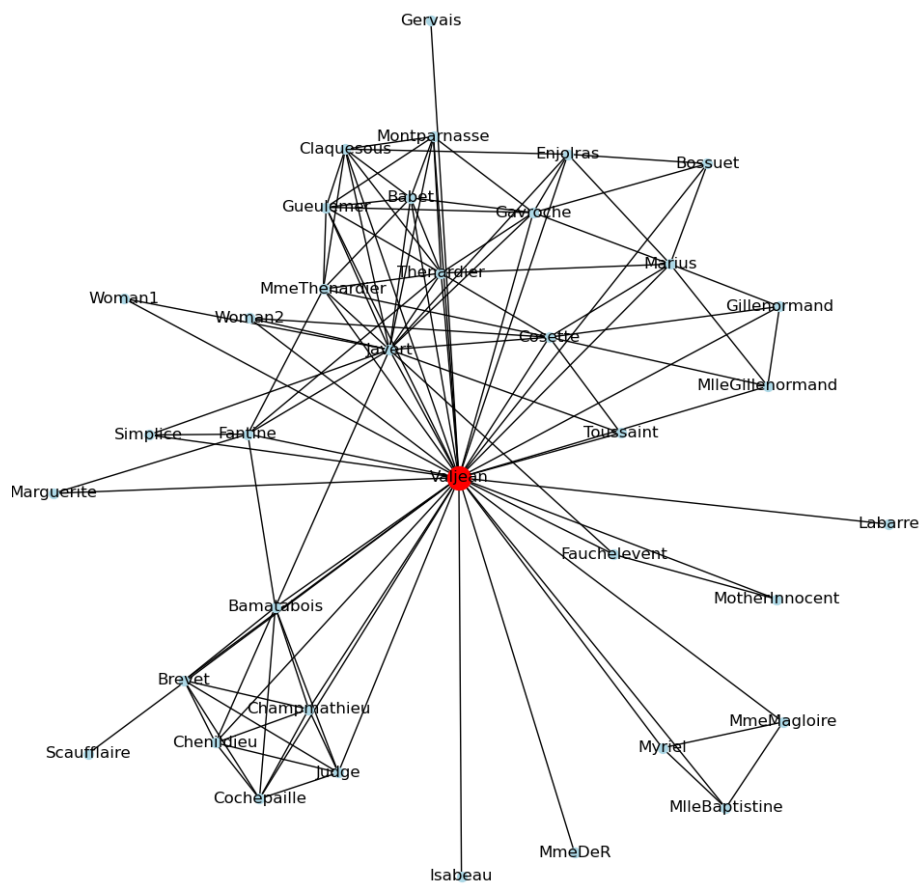


Figure 1: lesmis ego graph

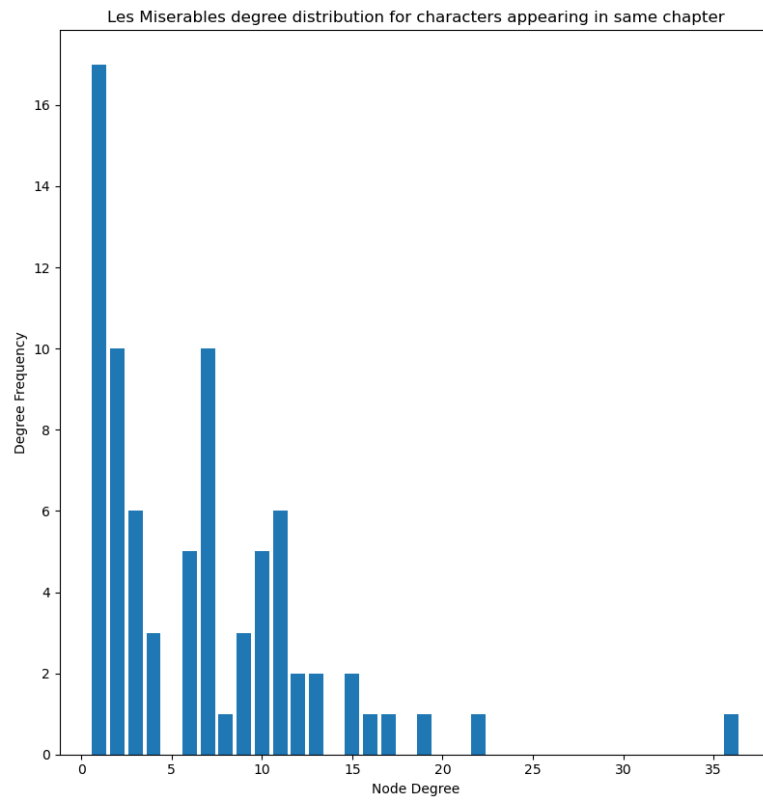


Figure 2: lesmis degree distribution

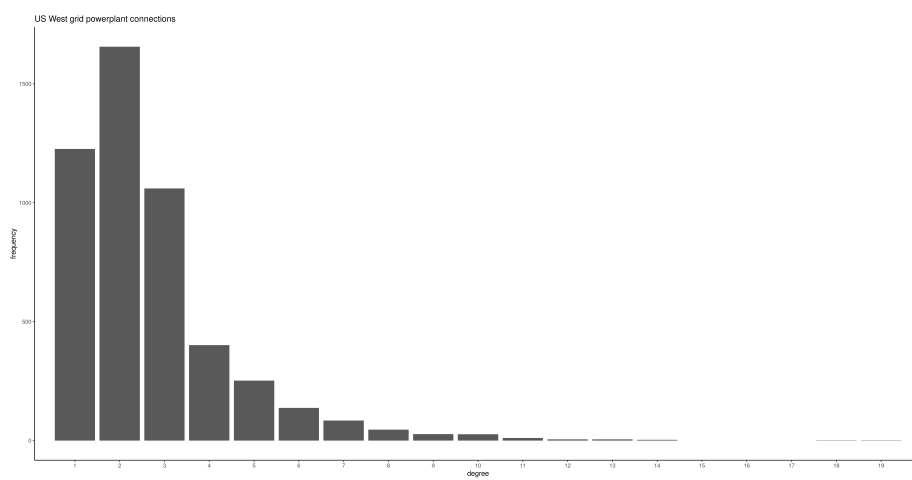


Figure 3: power degree distribution

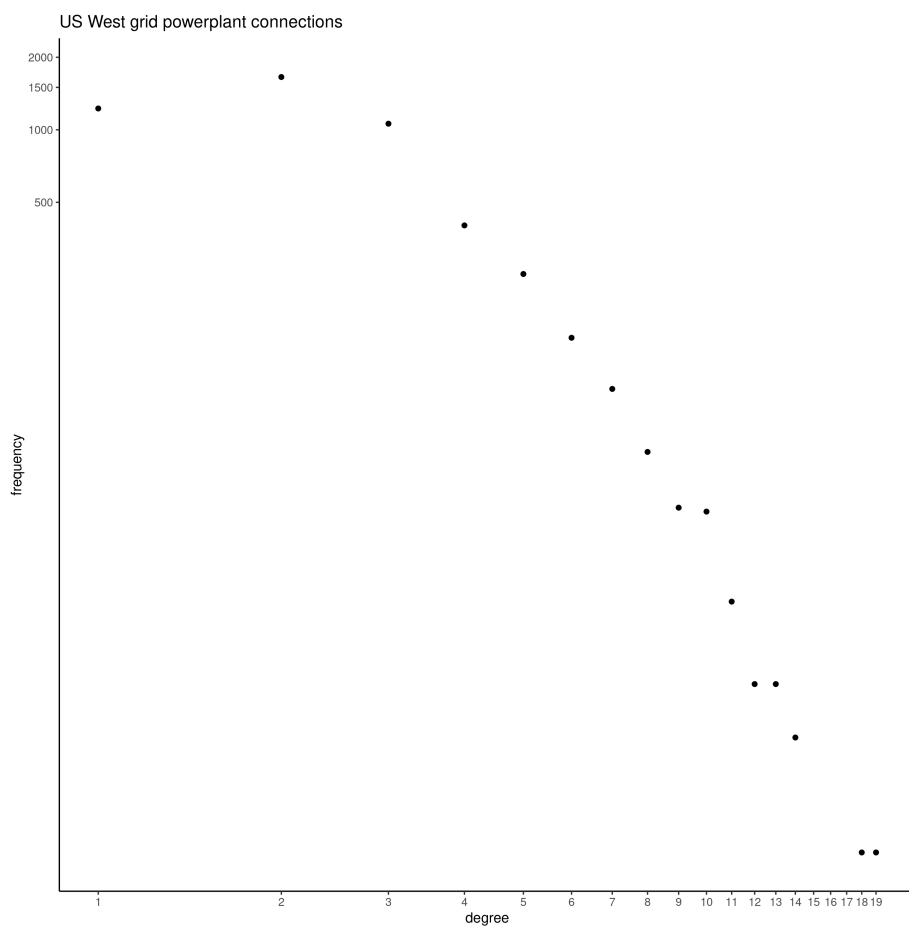


Figure 4: power degree distribution

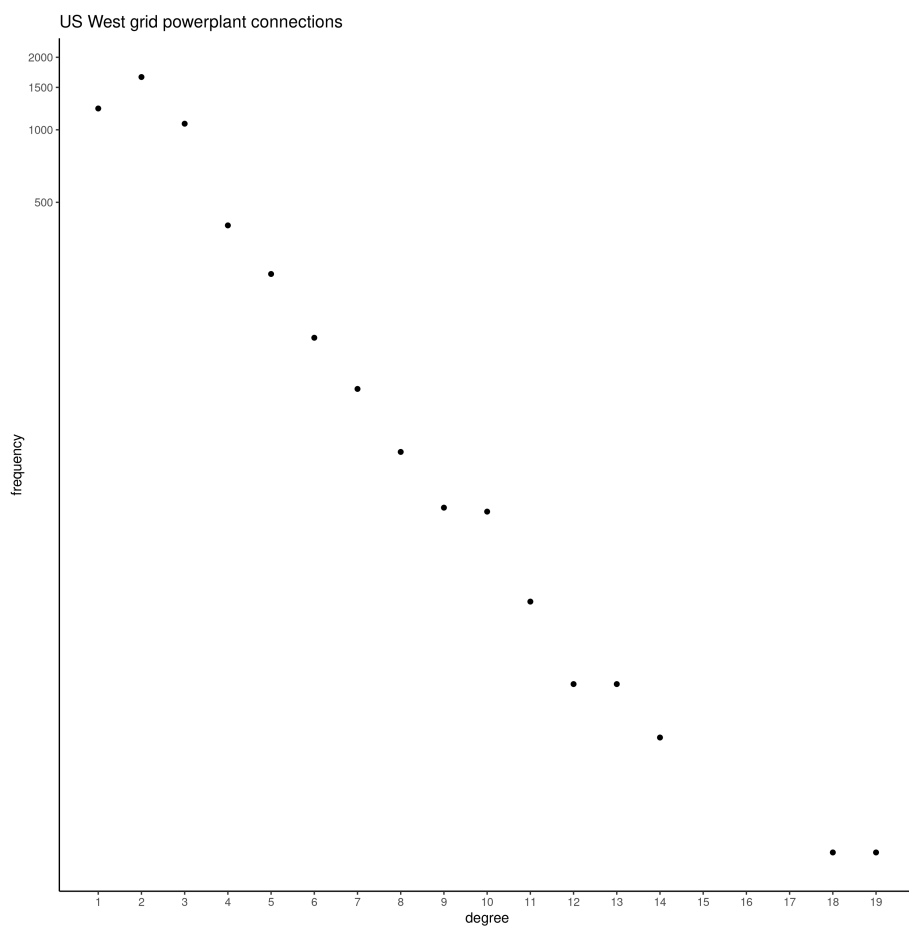


Figure 5: power degree distribution

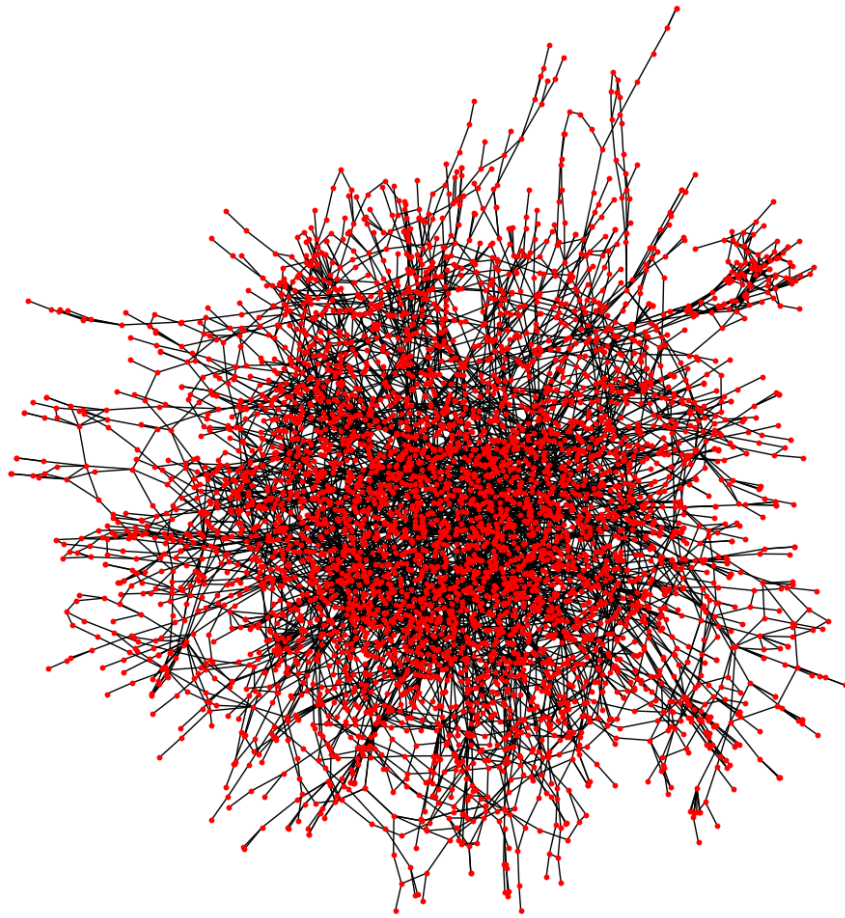


Figure 6: power network visualization

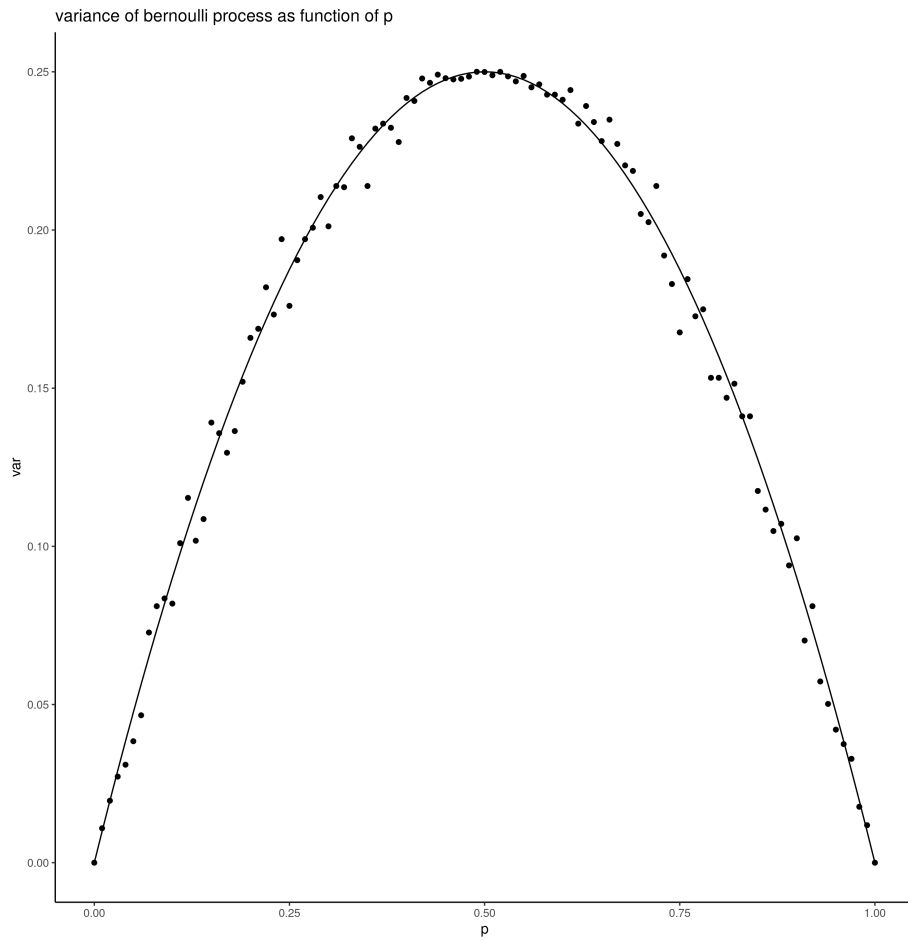


Figure 7: bernoulli process variance, with overlaid $p(1 - p)$:

2 Mathematical Toolbox

- (2. a) Fig. 7 shows that the computed variance matches the mathematics. The mean was computed to be p .

3 Connectedness

References

- [1] H. Lietz, Watts, Duncan J./Strogatz, Steven H. (1998). *Collective Dynamics of » Small- World « Networks. Nature 393, S. 440 - 442.*, pp. 551–553. 01 2019.
- [2] M. E. J. Newman, “Finding community structure in networks using the eigenvectors of matrices,” 2006.